METHOD AND APPARATUS FOR MARKING WORKPIECES

FIELD OF THE INVENTION

[0001] This application is a continuation-in-part of prior Application Serial No. 09/688,094 filed October 16, 2000.

[0002] The present invention relates to a method and apparatus for marking workpieces on a punching press, wherein the marking tool is forced by means of the punching stroke either against the surface of the workpiece or a certain depth into the surface of the workpiece. The workpiece, which is generally a piece of flat sheet metal, is displaced within its plane in order to create a straight or curved marking line.

BACKGROUND OF THE INVENTION

[0003] There is an increasing demand for altering the surface of workpieces, including as one example, providing workpieces with individual identifications. In this connection the use of stamping dies is not always practical because the stamping is often also visible on the back of sheet metal workpiece. Difficulties in connection with stamping dies occur particularly when it is intended to punch parts of different lengths out of a sheet metal workpiece (e.g., in order to minimize waste) and wherein a certain orientation of the marking on the workpiece is desirable.

[0004] A known method for marking sheet metal consists of embossing dot matrices to produce an alpha-numeric symbol with the aid of a pointed embossing tool. The workpiece must be moved stepwise after each dot has been embossed. This results in a multitude of required stamping stroke cycles, just to represent a single symbol. Besides the large amount of required time and the increased wear of the

driving mechanism for the stroke, which is driven in a quasi load-free manner, the loud noise is considered to be a disadvantage. A coarser dot matrix does simplify the marking process, but it also results in a more unsatisfactory matrix.

[0005] A qualitatively appealing marking can be achieved by inscribing markings into the surface of the workpiece, wherein no waviness or "rear embossing" will occur. Borries Markiersystem GmbH of Pliezhausen, for example, offers a machine, by means of which inscribing the desired identification is possible by displacing a tip forced into the surface of the workpiece in accordance with the contours of the marking.

[0006] It would seem that in principle one could employ such a known marking device in a punch press. However, if this were done, the space available for the main punching operation would be reduced and the progress of the main punching operation would be made more difficult. Also, this marking device could only operate within a limited portion of the area of the punch press so that movement of the sheet metal workpiece in order to apply markings on different areas thereof would become more difficult.

SUMMARY OF THE INVENTION

[0007] It is an object of the present invention to create an improved method and apparatus for altering the surface of a sheet metal workpiece, which method and apparatus can be integrated into a punching process in a punch press.

[0008] This object is attained in accordance with the invention by a method and apparatus wherein a tool is equipped with a tip which, after having been forced against or into the surface of the workpiece, is maintained at a fixed position, at which time the

workpiece is displaced in its plane in accordance with the desired result, and thereafter the tip is moved away from the workpiece to its rest position.

[0009] The principles of the present invention can be utilized to mark workpieces in many different ways. For example, a tool can be forced to a certain depth into the surface of the workpiece for an inscribing action. Or, a tool can be forced against the surface, without going beneath the surface, for the purpose of marking the surface. In another application, if the workpiece has a protective plastic cover over a metal base, such as a sheet metal base, a tool can be utilized to cut the plastic cover, while not altering the underlying metal sheet. In another application of the present invention, a deburring tool can be brought against previously formed holes to remove burrs. For convenience, all of these various applications of the present invention will be referred to as marking the workpiece, and the different apparatus and tools will be referred to as marking tools, or marking apparatus.

[0010] The production of markings of any arbitrary symbol or shape on or in the workpiece surface is made possible by means of the marking tool being placed on the punch press without any additional, space-consuming devices. At the same time the marking method is optimally integrated into the punching process so that, for example with a turret punch press, a sheet metal workpiece is first marked at the desired locations and thereafter is finished by means of the tools seated in other holders of the punch press. The marking tool may be arranged in a punch tool holder or in a holder on the workpiece support table of the punch press, so that the marking can be made from above or below the workpiece, as required. The orientation of the marking can be determined by means of the software which controls the workpiece driving mechanism.

[0011] It is also advantageous in connection with the method of the invention that the tool tip need be moved only once into its marking position, so that the number of punch strokes which must be performed by the punch press is considerably reduced. The results are reduced noise generation and reduced wear of the stroke driving mechanism.

[0012] In one preferred embodiment of the invention, at least a portion of the punch stroke is absorbed by an elastic element which extends between a table for seating the workpiece and the punch tool holder.

[0013] Since punch presses are designed for very high processing forces, with high precision and almost load-free, it can be very difficult under certain circumstances to move the stroke driving mechanism into a precisely defined position. To compensate for this, it is possible by an elastic element to achieve considerably more precise movement of the tool tip on or into the surface of the workpiece. In the process, the elastic element translates the relatively large punch stroke of the punch press into an exactly defined contact pressure force of the tool tip, which leads to the desired marking position.

[0014] In a further preferred embodiment of the invention at least one marking is formed as center mark, wherein, following pressing the tool tip, the workpiece is maintained in its predefined position until the marking tool is retracted.

[0015] It is desirable for some applications to be able to set a center mark on the workpiece, for example in order to be able to position or center bolts or pins which are to be welded onto the workpiece. The provision of the center mark can be integrated into the marking process and apparatus in accordance with the invention, wherein it

might be advantageous if, in connection with a center mark, the tool tip were pressed deeper into the workpiece than the usual inscribing depth.

[0016] For example, when making a center mark it is possible in a further development of the invention that by different positioning of the tool tip with respect to a counter-support, for example, the spring travel of the tool tip reaches its maximum before it has reached the deepest depth in the workpiece. While making surface marks or inscribing are performed by means of a resilient tool tip, the latter rests against a stop when making a center mark.

[0017] It has been shown to be practical to guide the workpiece by means of at least one support roller in the area of the workpiece table and/or the punch tool holder since, among other things, the support rollers or support balls provide the required counter support while not hampering the displacement of the workpiece.

[0018] One preferred apparatus for carrying out the method of the present invention comprises a marking tool and a counter-support on the opposite side of the workpiece, wherein the marking tool has a tool tip which can be forced in against the restoring force of an elastic element and which can be fixed in place in a punch holder or in the workpiece table of a punch press. The counter-support can be fixed in place on the punch holder, in the table or on the punch holder. It is possible, with the aid of at least one marking tool with a resilient tool tip and the appropriate counter-support, to execute the marking or center marking operations on a punch press with its workpiece which is movable in its plane. It is basically of no significance whether the marking tool is arranged below or above the workpiece, or whether marking tools are provided on both sides of the workpiece in order to mark both sides thereof in cooperation with

appropriate counter-supports. With such an apparatus, one marking tool and one counter-support in combination can constitute one half of the apparatus above or below the workpiece.

[0019] The counter-support preferably has at least one rotatable support roller or support ball for the movable support of the workpiece. As previously mentioned, balls or rollers provide a dependable support. Moreover the balls or rollers provide mobility without damage to the surface, and minimize frictional losses such that they occur only at the contact points between the workpiece and rollers.

[0020] The marking tool preferably includes, besides the tool tip, rotatable support rollers or support balls, which are seated in an elastically spring-loaded manner.

[0021] With an arrangement of this type, the workpiece first comes into contact with the support rollers or support balls during a punching stroke. The support rollers or balls yield elastically until, prior to reaching bottom dead center, the tool tip comes into contact with the surface of the workpiece. Contact pressure is then built up during the further downward movement. The spring travel of the support rollers or support balls is preferably greater than the spring travel of the tool tip. Thus, it is possible when setting a center mark that the tool tip rests against a stop, because of which an exactly defined center mark depth results. Center marking requires a precise approach to its final position.

[0022] The resilience of the elastic elements of the support rollers is suitably less than that of the elastic element of the tool tip in order to achieve a sufficient contact pressure when applying the marking symbols, and in order to introduce only small

forces into the workpieces by means of the support rollers or support balls, noting that the sheet metal workpiece can be comparatively thin. However, the resilience of the support rollers or support balls should be sufficient for supporting the workpiece during the operation.

[0023] For an inscribing marking tool, a tool with a cone shaped tip is used. The tip is preferably forced into the workpiece surface, so that an inscribing force is achieved regardless of the direction of movement. Shapes which are not round are also conceivable. Moreover, the inscribing element may cut grooves of different thicknesses into the workpiece surface.

[0024] In accordance with yet another preferred embodiment, the marking tool has an adjustable support, by means of which the position of the tool tip and/or the prestress of its elastic element can be adjusted.

[0025] The adjustable support makes possible the individual adaptation of the contact depth, for example in order to improve the clarity of the shapes formed in the workpiece, or to make possible an adaptation to the material of the workpiece.

[0026] As mentioned above, with the present invention, it is possible to make a marking such as an ink marking or the like on the surface of the sheet metal instead of inscribing the marking into the sheet metal. Making an ink marking would use the same method and apparatus as described above with respect to inscribing except that the method and the equipment would be adjusted such that the marking tools such as a pen or the like would simply be forced with sufficient pressure against the surface of the workpiece, as opposed to entering into the surface of the workpiece. Any suitable pen

could be used including for example, a ball-point pen, a roller ball pen, a felt tip pen or a grease pencil.

[0027] Alternatively, a marking tool made of brass, plastic or any other material which is incapable of cutting the workpiece may be utilized for the purpose of marking a shape in a protective covering placed over the workpiece without damaging the workpiece. Another marking tool may be used to remove burrs on the surface of the workpiece.

[0028] Thus, it is an object of the present invention to provide a new and improved method and apparatus for marking a workpiece, wherein the apparatus is incorporated within a punch press.

[0029] It is another object of the present invention to provide a new and improved method and apparatus for marking a sheet metal workpiece in conjunction with a punch press, wherein the marking can be either inscribed into the surface of the workpiece, made as an ink marking on the surface of the workpiece, made as a cut in a protective covering placed over the workpiece or as a mark to remove burrs in the workpiece.

[0030] It is still another object of the present invention to provide a new and improved method and apparatus for marking a sheet metal workpiece in conjunction with a punch press, wherein the marking can be made on either side of the workpiece, with suitable support provided on the other side of the workpiece.

[0031] These and other objects of the present invention will become more apparent from the detailed description to follow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] The invention will now be described in detail with respect to preferred embodiments of the invention wherein:

[0033] Fig. 1 is a central cross sectional view of a marking tool for insertion into a punch holder;

[0034] Fig. 2 is a central cross sectional view of a marking tool for insertion into a holder on a workpiece supporting table of a punch press, wherein the right and left sides show two different positions;

[0035] Figure 3 is an enlarged view of a portion of Figure 2, but showing a modification thereof;

[0036] Fig. 4 is a central cross sectional view of a marking tool similar to Figure 2, but showing a modification thereof; and

[0037] Fig. 5 is an enlarged view of a portion of Figure 1, but showing a modification thereof.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0038] Referring now to the drawings, like elements are represented by like numerals throughout the several views.

[0039] Referring to Figure 1, the marking tool has a guide bush 14, in which a support 16 is axially guided, and a driving head 20, which are in engagement with each other via a threaded connection 22. By means of a guide insert 24, the support 16 holds a marking tool 26, which is axially movable with respect to the support 16 and has a tool shaft 28 which is guided in an appropriately fitted bore 30 of the guide insert 24, a

pressure plate 32, formed at the top of the shaft 28, as well as an inscribing element 34, seated on the free lower end of the shaft 28. The tip 34 of the marking tool can be of different constructions, depending on the type of mark to be made. In a first embodiment, the tip 34 may be made of a hard material and shaped as a pointed cone to be used as an inscribing element. As an inscribing element, 34 can be made, for example, of a diamond, boron nitride, a hard metal, or an otherwise suitable material for inscribing the respective workpiece.

[0040] The axial mobility of the marking tool 26 in relation to the support 16 is limited by a first shoulder 36 of a bore 38 in the support 16, and by the top 40 of the guide insert 24 inserted into the bore 38. A compression spring 44, arranged under prestress between a second shoulder 42 and the pressure plate 32, urges the pressure plate 32 downwardly against the top 40 of the guide insert 24.

[0041] In the exemplary embodiment represented, the workpiece 12 is a sheet metal plate which rests on a tool holder 46 with a rotatably seated ball 48, wherein the contact point between the workpiece 12 and the ball 48 lies exactly in alignment with the inscribing element 34.

[0042] To inscribe a symbol on the workpiece 12, the workpiece is first appropriately aligned with the marking tool 10. Thereafter, lowering of the marking tool 26 is started by actuating the stroke driving mechanism of the punch press, which acts on the driving head 20, wherein the guide bush 14 is urged against the support 16 by means of a shoulder 50. In the course of the downward movement of the support 16 the marking tool 26 is initially moved along until the element 34 rests on the surface to be cut. The continued downward movement of the support 16 leads to compression of

the compression spring 44, and therefore the pressure exerted on the pressure plate 32 steadily increases. Where the element 34 is a diamond tip, it will actually penetrate the surface of the workpiece as a result of the pressure exerted by the compression spring. Maximum penetration depth is reached at the end of the punch stroke.

[0043] In some applications, it is desirable to use an element 34 which is not capable of penetrating the surface of the workpiece 12. Here, instead of utilizing a diamond tip, the element 34 is constructed from a material which does not penetrate the workpiece. It is often desirable to protect the workpiece 12 from inadvertent scratches or other blemishes which can occur during processing. For example, if the workpiece is stainless steel and will ultimately be used in the manufacture of an appliance or the like, the workpiece 12 may be covered with a plastic film or other protective covering during the hole punching or cutting operations. In order to create holes in the workpiece 12 in such cases, it is desirable to remove areas of the protective covering where the workpiece 12 will eventually be cut by a punch or a laser. This is necessary because the protective covering may interfere with the accuracy of such cuts in the workpiece 12. In order to cut holes in the protective covering without damaging the workpiece 12, a marking element 34 constructed from plastic or brass, or another material which is too soft to penetrate the workpiece may be utilized. Thus, when pressure is exerted by the compression spring, the element 34 will penetrate the surface of the protective covering (not shown), but will not penetrate the surface of the workpiece 12.

[0044] An adjustment of the penetration depth of the element 34 (when used as an inscribing element) can be performed by a relative turning of the driving head 20 in

relation to the support 16. This changes the effective total combined length of support 16 and driving head 20. With this increased length of the support 16 and driving head 20 the element 34 reaches the surface to be cut earlier in the punch stroke and the pressure built up by means of the compression spring 44 becomes correspondingly greater.

[0045] As an inscribing marking tool, as soon as the element 34 reaches its inscribing position, the stroke driving mechanism of the punch press is blocked. Conversely, if the stroke driving mechanism of the punch press did not permit the marking tool to stop in the inscribing position, a separate detent device must be provided between the support 16 and the guide bush 14. With the element 34 held down, the workpiece 12 is now displaced in its plane in order to form the contours of the symbol or shape to be inscribed, wherein any arbitrary orientation of the symbol or shape is possible by an appropriate control of the workpiece driving mechanism. When the symbol or shape has been completely inscribed, the stroke driving mechanism is reversed, wherein first the support 16 is moved away from the workpiece 12 because of the diminishing pressure force by the spring 44 and, following the contact of the pressure plate 32 with the top 40 of the guide insert 24, the element 34 is lifted off the workpiece 12. The workpiece 12 is appropriately horizontally displaced within its plane and the inscribing process is repeated for inscribing additional symbols or shapes.

[0046] During the horizontal displacement of the workpiece 12, the roller body 48 of the counter-support 46 follows this movement, wherein an optimal counter-support directly in alignment with the inscribing element 34 always exists. Because the roller

ball 48 turns, sliding movements against the underside of the workpiece 12 are prevented, so that the underside of the workpiece 12 is not detrimentally affected.

[0047] Where the marking tool of Figure 1 is used in a punch press the guide bush 14 is adapted to the tool holder and the driving head 20 is adapted to the stroke driving mechanism of the punch press.

[0048] The compression spring 44 can be replaced with a pneumatically or hydraulically operating pressure spring.

[0049] Figure 2 illustrates a marking tool 100, which can be inserted into a support on the workpiece supporting table of a punch press. The marking tool 100 has a housing 102, which has a circular bore 104, in which is received a ring-shaped holder 106. The ring-shaped holder 106 is resiliently axially supported in the punching direction by means of several helical springs 110, which are located within the circumference of a first shoulder 108. The holder 106 has two or more recesses 112, in which inserts 116, which rotatably receive support balls 118, have been fixed in place by means of threaded bolts 114. Even in the maximum retracted resilient state, as shown on the right side of Figure 2, the support balls 118 project upwardly past the upper edge of the housing 102. In its uppermost position, as shown on the left side of Figure 2, the upward movement of holder 106 is limited by a retaining ring 120, against which an annular shoulder 122 of the ring-shaped holder 106 rests. It would also be within the invention to provide a separately embodied holder with an associated helical spring in place of a ring-shaped holder 106.

[0050] As shown in Figure 2, the marking tool 100 moreover has a marking tool 124 with a cone-shaped tool tip made of a suitable material, for example a hard

alloy. The tool tip 124 has been inserted via a screw thread 126 into a bore 128 of a tool holder 130, which is resiliently supported by means of a helical spring 132 on a bottom cover 134. In this embodiment, the cover 134 has been screwed into a screw thread in the bottom of housing 102. This arrangement allows the replacement of the tool tip 124 without the necessity to completely dismantle the marking tool.

[0051] The tool holder 130 is guided in a guide bore 135 of a housing element 136, which is screwed together with the housing 102 by means of a screw connection. A rotation guard 138 in the form of a bolt prevents relative rotation between the tool holder 130 and the housing element 136.

[0052] A detent flange 142 provided on the tool holder 130, together with its detent face 144 on the housing element 136, limits upward movement of the tool holder 130. In the other direction, the maximum retracted resilient position of the tool holder 130 with the tool tip 124 is limited by the bottom face 146 of the tool holder 130 engaging the bottom cover 134, wherein the travel of the springs 110 of inserts 116 is greater than the travel of spring 132 the of tool holder 130. In the uppermost position of the springs 110 and 132 and the inserts 116 the support balls 118 project upwardly past the tool tip 124, while in the maximum retracted resilient state of the inserts 116 and of the tool holder 130, the tool tip 124 projects upwardly slightly past the tops of the support balls 118.

[0053] A tool corresponding to the marking tool 100 and having a further tool tip can be provided in the area of the punch holder of the respective punch press. It is also within the invention to provide only a simple counter-support with support balls, which can be aligned with the support balls 118 of the marking tool 100. A reverse

arrangement is also within the invention, wherein only a counter-support with support balls 118 is provided on the table side, and a tool similar to the tool 100 is provided in the punch holder.

[0054] During operation, a workpiece to be marked, normally a sheet metal piece, initially rests on the support balls 118 of the tool 100 and is not in contact with the tool tip 124. In this position the sheet metal workpiece can be displaced horizontally in its plane without the tool tip 124 causing damage to the surface. After the sheet metal workpiece has been moved into a position in which it is to be marked, a punch stroke is initiated. In the course of this stroke, the sheet metal workpiece is moved downwardly, for example by pressure balls on the top of the workpiece, wherein the inserts 116 are lowered against the force of the helical springs 110. The tool tip 124 reaches the surface of the sheet metal workpiece, and the prestressed spring 132 of the tool holder 130 is compressed by means of continued lowering, because of which a contact pressure force of the tool tip 124 is built up on the surface of the sheet metal workpiece. In one embodiment the tip 124 is constructed of a material such as diamond, which is capable of slightly penetrating into the material of the workpiece under this contact pressure force. If shapes are to be inscribed into the surface of the workpiece, the bottom dead center position is set in such a way that the tool holder 130 does not yet rest against the bottom cover 134. Therefore the penetration depth of the tool tip 124 remains relatively slight. Thereafter the sheet metal workpiece is displaced horizontally in its plane in accordance with the contours of a shape to be inscribed. The top dead center position of the punch holder is then again approached. Now the

position of the sheet metal workpiece can be moved and, if desired, further shapes can be inscribed.

[0055] As described above with respect to tool 34 of Figure 1, tip 124 may also be constructed of plastic or brass or another material suitable for cutting holes in a plastic sheet or other protective covering over the workpiece without actually marking the surface of the workpiece.

[0056] The provision of a center mark in a workpiece is also possible by means of the marking tool 100, for example as an alignment aid for pins or bolts to be welded onto the workpiece during subsequent work steps. To this end the sheet metal workpiece at bottom dead center is moved further downward by means of an increased punch stroke, or by means of a tool tip 124, which can be adjusted in a suitable manner, or by means of a position adjustment of the pressure balls, or the like, because of which the bottom face 146 rests against the bottom cover 134 before bottom dead center has been reached. By means of the subsequent lowering by a further short distance, a center mark of a desired depth is made which clearly extends to a depth which is deeper than the inscribed symbols.

[0057] Figure 3 illustrates another embodiment 200 of a marking tool. The embodiment of Figure 3 is similar to the embodiment of Figure 2 except for certain modifications. Accordingly, those elements in Figure 3 which are identical to Figure 2 are represented by the same numeral. Those elements which have been modified have been raised by 100 relative to the numeral used to describe the related part in Figure 2.

[0058] In contrast to Figure 2, Figure 3 shows a tool tip 224 which is a diamond seated in a shaft 226. This shaft 226 has been fixed in place by means of an attachment screw 228 on a tool holder 230. The essential difference of the tool holder 230 in comparison with the tool holder 130 of Fig. 2 is that the tool holder 230 has an increased free space between its bottom face 246 and the bottom cover 234, so that even with the holder 106 being maximally retracted resiliently and resting against the first shoulder 108, the spring travel of the tool holder 230 is not at its maximum compression. Therefore the marking tool represented in Fig. 3 is only suitable for inscribing symbols wherein the greater hardness of the diamond tip 224 provides a longer service life, while the increased travel of spring 132 protects the diamond tip from shocks caused by engaging the detent 142.

[0059] As described above, the described tools for marking and possibly providing center marks can be used on the workpiece supporting table side as well as on the punch holder side, so that processing of both sides of the workpiece is possible.

[0060] Figure 4 shows how the marking tool of Figures 2 or 3 acts as a deburring tool to remove rough edges 335 created on the underside of a workpiece 12 when a hole 336 has been created in the workpiece 12 by a punch or laser. The tool tip 124' is contacted with the underside 12' of the workpiece as described in connection with Figures 2 and 3. The tool tip 124' is placed in contact with the rough edges 335 around the hole 336. The tip 124' is constructed of a hard material that is suitable for removing the rough edges 335. The workpiece 12 is then displaced horizontally in its plane so that tip 124 contacts and removes the entire raised edge portions around the perimeter of hole 336.

[0061] Figure 5 illustrates a modification of the present invention wherein, instead of an inscribing element, there is provided an ink point 334 for marking the surface of the workpiece 12 without penetrating same. Ink point 334 is shown at the lower end of a shaft 334 mounted in guide insert 24 of Figure 1. All of the above described features of all embodiments of the invention can utilize an ink point 334 to mark the surface of a workpiece in place of the previously described elements for inscribing the workpiece and/or forming a center mark. As would be understood by one of ordinary skill in the art, when using an ink marking point 334, one would simply adjust movements of all of the other movable parts such that instead of penetrating the workpiece, the apparatus would move the ink point 334 to a position where it exerted sufficient force onto the workpiece to form an ink marking. As with the other embodiments, the workpiece 12 could then be displaced horizontally within its plane so as to form an ink shape or symbol of straight or curved lines. Any type of known ink point could be used such as a ball-point, a roller ball point, a felt tip or a grease pencil.

[0062] Although the invention has been described in considerable detail with respect to preferred embodiments thereof, it will be apparent that the invention is capable of numerous modifications and variations, apparent to those skilled in the art, without departing from the spirit and scope of the invention.